Recent Paleoecology of Hager Lake Fen, Idaho, and its Relevance to Rare Plant and Ecosystem Conservation

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"Paleoecology of Peatlands at Huff and Hager Lakes, Idaho Panhandle National Forest"
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RECENT PALEOECOLOGY OF HAGER LAKE FEN, IDAHO, AND ITS RELEVANCE TO RARE PLANT AND ECOSYSTEM CONSERVATION

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INTRODUCTION

Species and populations must respond to environmental changes and disturbance regimes occur over a variety of spatial and temporal scales (Schoonmaker and Foster 1991). Disturbance events in wetlands can be bring about changes in hydrology and cation concentrations of waters leading to the creation of habitat suitable for a narrow suite of species (Miller 1990). Varying levels of disturbance create or maintain a mosaic of successional seres vital for the long-term maintenance of biodiversity within a unique habitat (Marcot et al. 1994).

Low-elevation, valley peatlands are rare in Idaho, where they are at the southern limit of their distribution (Bursik 1990). They represent small habitat islands characterized by a

unique suite of environmental characteristics suitable to relatively few species. The peatland islands are surrounded by many hectares of terrestrial forest, consequently either long distance dispersal or persistence of relict populations must account for the floristic composition of these sites (Bursik 1990). Valley peatlands in Idaho are similar to other peatland floras in north-temperate North America, being characterized by numerous boreal species (Bursik 1990; Bursik and Henderson 1994). Due to the rarity of the habitat in Idaho, however, more than 30 vascular species having primarily boreal distributions are considered rare in the state (Conservation Data Center 1994). Consequently, there is much interest in the conservation of these habitats and the maintenance of ecological processes that have allowed for the long-term persistence of rare plant populations.

Vegetation research conducted at Hager Lake Fen, Idaho, during the early 1950's (Rumely 1956) was redone in 1992 (Bursik and Moseley 1992). Fourteen vascular plants had become extirpated from the site during the intervening four decades, four of which are rare in Idaho. Nine species had immigrated to the fen during the same period. Significant changes in surface water chemistry, floristic composition, and the spatial arrangement of community types were also documented (Bursik and Moseley 1992). It was unknown whether this species turnover is attributable to human activities in and around Hager Lake Fen or were part of an inherent cycle of extirpation and recolonization within a dynamic ecosystem.

To test which of these two scenarios may be closest to the long-term ecological trend within Hager Lake Fen, we undertook a paleoecological study to address the question of change. We are specifically interested in characterizing the temporal pattern of community and plant population flux within the fen over the past several hundred years and determining if there is evidence of pulses of species loss and colonization during this time. Our goal was to ascertain whether or not floristic changes documented between 1952 and 1992 are within the range of presettlement ecological variability or a consequence of recent human disturbances in the area to which some species are unable to adapt. Our results will have a direct bearing on peatland habitat conservation planning currently underway in northern Idaho.

STUDY AREA

Hager Lake is a 2 ha pond located in the Priest River Valley, Bonner County, Idaho, (48°, 35′, 50" N latitude, 116°, 58′, 8" E longitude) at an elevation of 860 m. The fen is of high conservation value in the state because of the presence of a rare peatland community and six vascular plants that have a limited distribution in Idaho (Conservation Data Center 1994). In addition, four rare vascular species are known to have been extirpated from the fen (Bursik and Moseley 1992; Table 1).

The Hager Lake basin is enclosed and underlain by ice-

contact fluvial gravels (Mack et al. 1978). The depression likely formed as a result of an ice block melting near the terminus of the glacier that occupied this portion of the Priest River Valley. Mack et al. (1978) estimated the depression dated from approximately 10,500 years before present. Cores taken in 1992, however, indicate the basin dates from earlier than 12,000 years before present, based on the presence of Glacier Peak tephra found near the bottom of the cores, which dates from about 11,700 years before present (Peter Mehringer, Washington State University, unpublished data) [Reference for tephra date?].

The climate of the Priest River Valley is best described as "inland maritime" due to the prevailing westerlies, which carry maritime air masses from the northern Pacific Ocean across the northern Rocky Mountains in the winter and spring (Cooper et al. 1987). Mean annual precipitation for the Priest River Experimental Forest, 32 km southeast of Hager Lake, is 81.3 cm, most of which occurs as snow during the winter. The mean annual temperature is 6.8° C, while the mean July temperature is 18.2° C and the mean January temperature is -4.6° C (Cooper et al. 1987). Vegetation of the Priest River Valley is dominated by mixed coniferous forest occurring in stands of varying ages. Prominent species include <u>Thuja plicata</u>, <u>Tsuga heterophylla</u>, <u>Pinus contorta</u>, <u>P. monticola</u>, <u>Abies grandis</u>, and <u>Pseudotsuga menziesii</u>,

Hager Lake is bordered on the south by a 1 ha floating peat mat dominated by <u>Sphagnum angustifolium</u>, <u>S. subsecundum</u>, <u>Scheuchzeria palustris</u>, <u>Vaccinium oxycoccos</u>, and <u>Kalmia</u>

microphylla (Figure 1). A narrow fixed mat, about 10 m wide, borders the pond on the east, west, and north. A similar fixed-mat community occurs in a narrow band between the floating mat and the dense Spiraea douglasii carr south of the lake. This habitat is classified as a poor to slightly minerotrophic fen (Gore 1983). The S. douglasii carr surrounds the fixed mat zone around the entire lake, extending to the peat-mineral soil boundary.

Approximately 15 m north of Hager Lake is a narrow stand of Pinus contorta occupying a moraine raised about 1 m above the lake. North of the moraine is an extensive Spiraea douglasii carr that grades into a S. douglasii/Carex lasiocarpa carr, which combine to cover nearly 25 ha (Figure 1). This area is a rich fen fed by minerotrophic groundwater, leading to dominance by "brown mosses", sedges and shrubs, rather than Sphagnum species.

Humans have affected the ecology of Hager Lake Fen for most of the 20th century. The Homestead Patent, including the lake and surrounding fen communities was granted in 1915. The forests to the west and east of the basin were logged in 1926 and 1945. The forest to the south of the lake was severely burned and subsequently cleared of slash in 1930 (Rumely 1956). Large Pinus monticola was logged west of the fen in 1955. Small-scale tree thinning has occurred since then in much of the area immediately surrounding the lake.

Although Hager Lake lies in a depression with no surface outlet, there has been several attempts to lower the water level

through ditches since the early part of this century (Rumely 1956). A main ditch exiting the lake and several laterals in the carr (Figure 1) affect the water level by hastening the movement of water from the lake and fen into Kalispell Creek. After the first ditching and draining, the Spiraea douglasii/Carex lasiocarpa carr was cleared of shrubs and hay was cut from the area up to the early 1940's. Pasture grasses were sown in the carr to improve hay quality. During the early 1940's, the former carr was also used as a goat pasture. Rumely (1956) reported that the area had not been pastured or cut since 1947. The most recent ditching took place during 1988.

METHODS

Coring

We selected a coring site in the fixed mat zone, which lies between the floating mat and the S. douglasii carr at the south end of the fen (Figure 1). We chose the fixed mat rather than the floating mat because it is anchored, thereby being more sensitive to water level fluctuations in the basin (Schwintzer and Williams 1974). To avoid compression of the exceedingly fibrous peat, we extracted the upper 108 cm by cutting the peat with sharpened tiling spades as a sharpened 15 cm diameter plastic barrel was being pushed into the deposit. In spite of these precautions, the 108 cm was compressed into approximately

75 cm.

Sample Preparation

The core was transported in the plastic barrel to the laboratory where it was frozen. Sediments were exposed by cutting the barrel lengthwise and removing the top half. Thus, the cores were protected during transport and freezing, and not distorted by extrusion or by splitting. The frozen core was then lifted from the barrel and 4 to 5 cm was trimmed from the edges with a bandsaw to eliminate possible contamination.

Frozen slabs were cut vertically from the trimmed core to make three 2 x 1.78 cm slabs the length of the frozen deposit. One of the slabs was cut horizontally with the bandsaw into 1.956 cm samples for pollen analysis. Replicate samples were cut from one frozen slab and were returned to the freezer awaiting additional study. Another frozen slab was returned to the freezer uncut as a full-length voucher specimen.

The remainder of the trimmed core was divided into 18 macrofossil samples approximately 4 cm wide. All macrofossil samples were thawed in water in beakers with stirring bars, which, upon thawing, were placed on magnetic mixers. They were allowed to spin from one to several hours to disperse the fibrous plant remains. As the peat separated, the samples were washed through nested screens with openings of approximately 2.0 mm, 1.0 mm, 0.5 mm, and 0.35 mm (10, 16, 32, and 42 mesh, respectively).

The various screen fractions were returned to the magnetic mixers for continued dispersal and additional screening until all plant remains were free and separated into four size fractions. The separates were stored in water and refrigerated until analyzed.

The lowermost sample (70.8-74.8 cm from the surface) was discarded when it was found to be contaminated with fresh remains of chlorophyllous sphagnum and leaves of Carex limosa. Contamination apparently occurred at the time of core extraction when it was pulled from the hole and rested on top of the mat.

Macro- and Microfossil Analysis

We prepared thirty-six pollen reference slides from Bursik's voucher collections (deposited at ID) and from specimens at the Washington State University Herbarium (WS). Macrofossil references were also made of seeds, leaves, and other potentially preserved parts of species currently found in Hager Lake Fen. These references, along with Levesque et al. (1988) and voucher samples from previous studies, were used to identify macrofossils. Vascular plant nomenclature follows Hitchcock and Cronquist (1973) and bryophytes follows Crum et al. (1973). We used Kuhry et al. (1993) to determine the indicator status of bryophytes.

Several leaf fragments of Kalmia microphylla were isolated for radiocarbon dating from sample 15, 58.8-62.8 cm from the surface. Dating was conducted at the Laboratory for Accelerator

Radiocarbon Research, Institute of Arctic and Alpine Research, University of Colorado at Boulder. Macrofossil analysis was qualitative. The general abundance of species remains were noted in each sample, but no quantitative protocol was developed to ascertain relative abundance.

RESULTS

Mount St. Helens T tephra, deposited in A.D. 1800, is present at the bottom of sample 10, near 42 cm (Table 2). The radiocarbon date for the Kalmia leaf fragments from sample 15 was 470 +/- 60 years before present. Using these two stratigraphic markers and assuming constant deposition rates above and below the tephra, each sample above St. Helens T represents approximately 20 years of fen history and each sample below represents approximately 50 years. The depth of peat per year likely decreases slightly with increasing depth due to compaction and settling. The compression resulting from the extraction method used to get the core may have obscured this somewhat, but it probably made the change in depth/decade more gradual. We estimate the total age of the 70.8 cm of analyzed core to be approximately 600 years.

We found the remains of two animals, six bryophytes, and 22 vascular plants in the core. Plant remains included leaves, stems, rhizomes, flower parts, seeds, and fruits. Five species, Sphagnum subsecundum, Calliergon stramineum, Vaccinium oxycoccos,

Kalmia microphylla, and Carex limosa are present in all samples (Table 2). Sphagnum angustifolium, Drosera anglica, Scheuchzeria palustris, and to a lesser extent, D. rotundifolia are present throughout much of the core. These species include all the major contributors to peat volume in the entire core, particularly the former five. Sphagnum centrale, currently the most prominent bryophyte on the fixed mat, is a minor peat contributor in the upper three samples.

The presence of the five major peat contributors in every sample gives the appearance of stasis at Hager Lake Fen during the last 600 years. When relative abundance is taken into account, however, a clearer picture emerges. Toward the base of the core, poor fen bryophyte indicators, such as Sphagnum angustifolium and S. centrale, are absent or in low abundance while rich fen indicators, such as Calliergon stramineum and S. subsecundum, are more prevalent. The same is true of the most important vascular peat contributors, Vaccinium oxycoccos and Carex limosa. These poor fen indicators (Vitt and Slack 1975) decreased in abundance with increasing depth.

The most dynamic time during the 600-year history of Hager Lake Fen represented by the core occurs in sample 7. This sample dates from around the turn of the century, when Europeans first began to settle the Hager Lake area. Several species, including Scirpus acutus, Calamagrostis canadensis, Ranunculus sp., and Juncus ensifolius appear for the first and only time in the core. While all of these species are still extant at the fen, they are

of limited prominence and generally occur at the fen margin where nutrient inflow from uplands is greatest. This position coincides with their minerotrophic, rich fen indicator status (Jeglum 1971; Vitt and Slack 1975). In addition, Scirpus acutus indicates a higher water level than currently exists at the coring site.

The turnover of three other species also indicates fluctuations in nutrient availability and water level at the coring site. Sphagnum teres is typically associated with wet, minerotrophic, rich fen conditions (Vitt and Slack 1975). Its presence in samples 3-8 may indicate an increase, and subsequent decrease, in nutrient availability and/or water level. Similarly, the presence of Drepanocladus sp. in samples 8-12, approximately 100 to 400 years before present, also indicates higher water levels in Hager Lake Fen prior to the arrival of Europeans. Drepanocladus contains species of swamps, bogs, streams, and lakes that are often aquatic and rarely mesophytic (Lawton 1971). The presence of Nuphar polysepalum seeds in sample 9 and 13 also provides evidence of higher water levels during this time.

DISCUSSION

Our sample core was extracted from the fixed mat, which does not rise and fall with fluctuating water levels as the floating mat does. During the wet period of approximately 100 to 400

years before present this portion of the mat would have been inundated for much or all of the growing season. It was inundated at least enough to allow the establishment of hydrophytic plants such as <u>Scirpus</u> <u>acutus</u>, <u>Nuphar</u> <u>polysepalum</u>, and <u>Drepanocladus</u> sp. Others have found similar patterns of change related to beaver damming, road building, and water level maintenance that affect hydrologic regimes in peatlands (Schwintzer and Williams 1974; Jeglum 1975; Wilcox and Meeker 1991; Mitchell and Niering 1993). As water levels dropped on the fixed mat at Hager Lake Fen, either naturally or by ditching, it became exposed for much of the growing season, allowing the growth of mesophytic peatland species. Such changes also favor poor fen species over rich fen species because the site becomes more isolated from groundwater nutrient influences (Kuhry et al. 1993).

Bursik and Moseley (1992) found that significant vegetation changes occurred throughout Hager Lake Fen between 1952 and 1992. Expansion of the <u>Spiraea</u> <u>douglasii</u> carr indicated lower water levels and decreasing periodicity and intensity of flooding through the period. Surface water chemistry data and changes in abundance of certain species, both on the fixed and floating mats, indicated that the mineral content of water in the pond and the fen had decreased since 1952. Our paleoecological and vegetation monitoring data mirror the results of others that have found the two most important factors affecting the distribution and abundance of peatland species are depth of water relative to

the peat surface and the mineral content of waters feeding the basin (Vitt and Slack 1975; Vitt et al. 1975; Schwintzer 1978; 1981; Miller and Futyma 1987).

Kuhry et al. (1993) found the typical pattern of peatland development in boreal Canada was from pond or marsh to rich fen to poor fen and finally to ombrotrophic bog. Based on our data, however, peatlands in northern Idaho appear to follow a less predictable, more variable successional sequence. This is probably related to the highly variable climate, characterized by a pronounced summer drought with low precipitation and humidity. These conditions appear to retard or reverse peatland succession or maintain it at a particular stage. Due to these conditions, Idaho lacks true ombrotrophic bogs, leaving poor fens as the end of the successional gradient. It may also explain why Idaho's peatland flora is more diverse than regional peatland floras elsewhere in North America (Bursik and Henderson 1994).

Only two of the ten rare species known to be extant or extirpated from Hager Lake Fen appear in the fossil record, *Vaccinium oxycoccos* and *Scheuchzeria palustris* (Table 2). Both species were major peat contributors during the last 600 years. While there is no direct evidence as the to population levels of the other eight rare species during the last 600 years, several things can be inferred from paleoecological and vegetation monitoring data about their response to changes in the physical environment of the fen.

It appears that repeated ditching, beginning around the turn

of the century and continuing until 1988, has kept the water levels in Hager Lake Fen lower than the previous 300 years. Conversely, surface waters became increasingly minerotrophic following logging and land clearing prior to 1952, but cessation and recovery from these disturbances, in combination with low water levels, caused subsequent oligotrophication during the last 40 years.

The four rare plants known to have become extirpated from Hager Lake Fen during this time are rich fen species of open habitats whose niches may only be maintained by periodic and sometimes persistent flooding. Changes in water level and nutrient status brought on by human-caused disturbances perhaps accelerated the rate at which habitat changes occurred, requiring specific populations of plants or vegetation zones to shift faster than they were capable.

Peatland community development is often thought to be autogenically controlled (Kuhry et al. 1993) and many Idaho land managers consider these small, isolated habitats to be relatively immune to the effects of management practices occurring on adjacent terrain. Our data suggest that at least near their southern limit, this is not the case and they are linked to external, landscape-level processes. Allowing the appropriate levels of disturbance are as important as maintaining adequate, undisturbed buffers for the long-term maintenance of biodiversity within the site. Long-term ecological monitoring at the fen will further elucidate some of the relationships talked about here.

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Table 1. Extant and extirpated rare vascular plant species from Hager Lake Fen. "*" denotes that the species was present in 1952, but not in 1992 (Bursik and Moseley 1992).

Carex leptalea *
Dryopteris cristata *
Epilobium palustre *
Hypericum majus
Lycopodium inundatum
Lycopodium obscurum *
Scheuchzeria palustris
Scirpus subterminalis
Trientalis arctica
Vaccinium oxycoccos

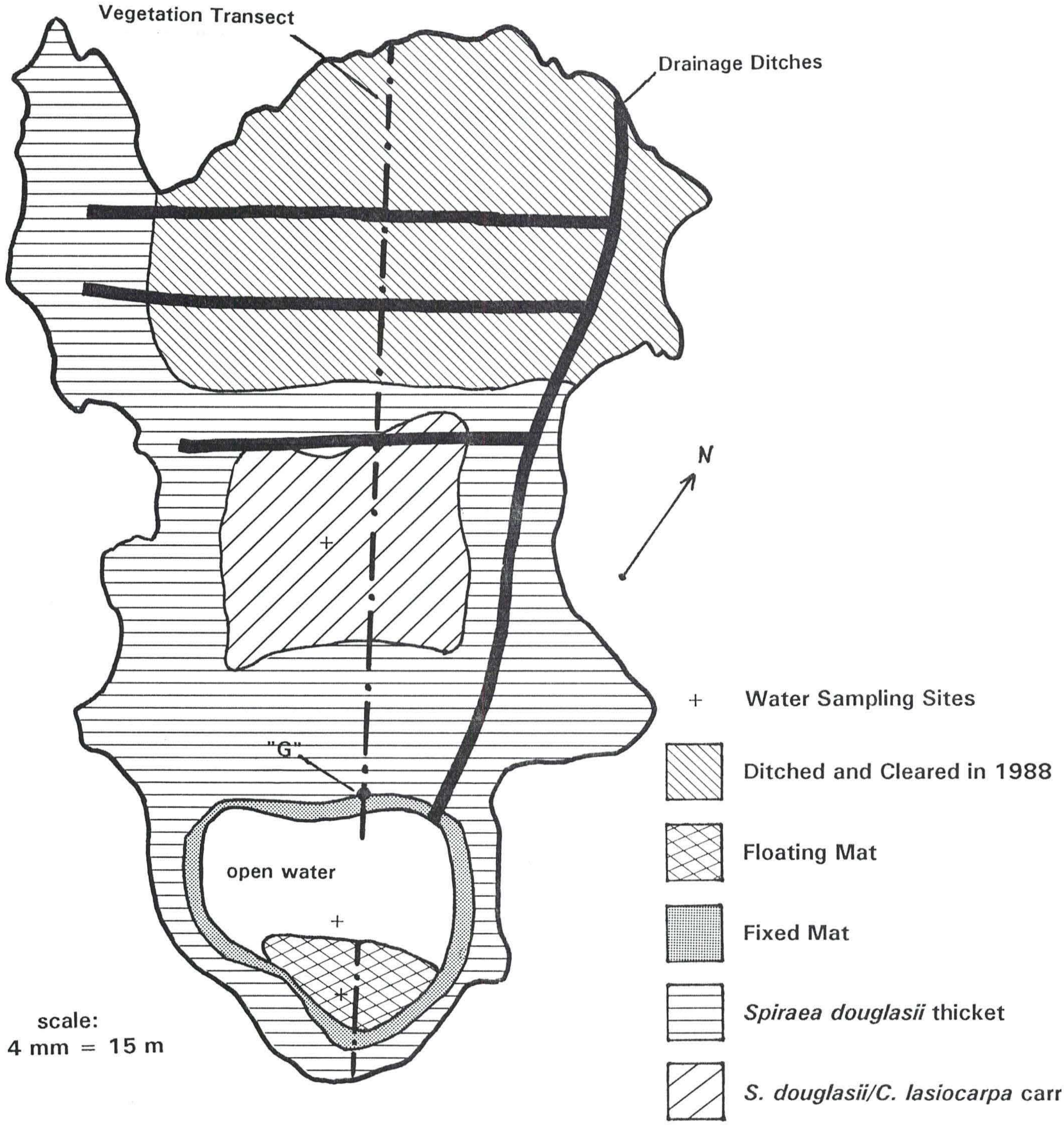

Figure ~~2~~ 1. Map of plant communities at Hager Lake Fen [modified from Rumely (1956)].

Table 2.

Sample	Depth from Surface (cm)	Sphagnum subsecundum	Calliergon straminium	Sphagnum angustifolium	Vaccinium oxycoccos	Kalmia microphylla	Carex limosa	Drosera anglica	Drosera rotundifolia	Sphagnum centrale	Scheurchzeria palustris	Hypericum majus	Sphagnum teres	Menyanthes trifoliata	Tsuga heterophylla	Scirpus acutus	Calamagrostis canadensis	Ranunculus sp.	Abies sp.	Juncus ensifolius	Drepanocladus sp.	Spiraea douglasii	Nuphar polysepalum	Carex canescens	Eleocharis pauciflora	Picea engelmanii	Larix occidentalis	Carex utriculata	Thuja plicata	Sponge statoblast	Daphnia sp.
1	0.0 - 5.5	x	x	x	x	x	x	x	x	x																					
2	5.5 - 9.5	x	x	x	x	x	x	x	x	x	x	x																		x	
3	9.5 - 13.5	x	x	x	x	x	x		x	x	x		x																		
4	13.5 - 17.5	x	x	x	x	x	x	x			x		x																		
5	17.5 - 21.5	x	x	x	x	x	x	x				x	x																		x
6	21.5 - 25.5	x	x	x	x	x	x				x		x	x																	x
7	25.5 - 29.5	x	x	x	x	x	x	x	x				x		x	x	x	x	x	x											x
8	29.5 - 33.5	x	x	x	x	x	x	x	x		x		x	x	x						x	x									x
9	33.5 - 37.5	x	x	x	x	x	x	x		x	x				x						x		x	x							x
10	37.5 - 42.8	x	x		x	x	x	x			x			x							x				x						
11	42.8 - 46.8	x	x	x	x	x	x	x			x										x					x					
12	46.8 - 50.8	x	x	x	x	x	x	x		x	x										x										
13	50.8 - 54.8	x	x	x	x	x	x	x	x		x	x											x				x	x	x		x
14	54.8 - 58.8	x	x	x	x	x	x	x	x		x				x																x
15	58.8 - 62.8	x	x		x	x	x	x	x		x																				x
16	62.8 - 66.8	x	x		x	x	x				x				x												x				
17	66.8 - 70.8	x	x	x	x	x	x	x							x																x